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ASEPTIC SPLICING DEVICE OF FLEXIBLE TUBES

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[There are no amendments to this patent.]

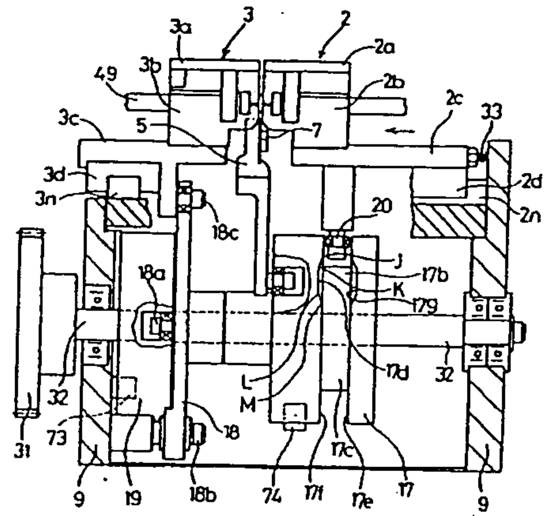
Abstract

Purpose:

The purpose of this invention is to provide an aseptic splicing device for flexible tubes characterized by the following facts: it makes the two movements, namely, the back-and-forth movement with respect to the first clamp and the movement towards the second clamp side and then backward and in the lateral direction, smoothly and with little error in the movement of the clamps; in addition, it facilitates the cleaning operation for the inner surfaces of the first and second clamps.

Constitution:

An aseptic splicing device for flexible tubes characterized by the following facts: it has first clamp (3) and second clamp (2) for keeping two flexible tubes parallel to each other, cutting means (5) for cutting flexible tubes (48) and (49) between said two clamps and a driving means for the cutting means, a first clamp driving mechanism which drives the first clamp to make movement parallel to the second clamp so that the splicing end portions of cut flexible tubes (48) and (49) are arranged facing each other, and a second clamp driving mechanism which drives the second clamp towards or away from the first clamp; the second clamp driving mechanism can drive the second clamp away from the first clamp when the first clamp has been moved parallel to the second clamp such that the splicing end portions of the flexible tubes are arranged facing each other.



Claim

An aseptic splicing device for flexible tubes characterized by the following facts: the device is for aseptically splicing flexible tubes; the device has the following parts: a first clamp and a second clamp for keeping at least two flexible tubes in a parallel configuration; a cutting means for cutting said flexible tubes between said first and second clamps; a first driving mechanism which drives said first clamp parallel with respect to said second clamp so that the end portions cut by said cutting means for splicing are arranged facing each other; a second clamp driving mechanism which drives said second clamp towards or away from said first clamp; and a cutting means driving means which drives said cutting means vertically between said first clamp and second clamp; in addition, as said first clamp is driven by the first clamp driving mechanism to move parallel to said second clamp so that the end portions cut by said cutting means for splicing are arranged facing each other, said second clamp driving mechanism can move the second clamp away from said first clamp by pressing said second clamp.

Detailed explanation of the invention

[0001]

Industrial application field

This invention pertains to a type of aseptic splicing device for flexible tubes which heats and melts at least two flexible tubes and splices them.

[0002]

Prior art

For tube splicing of the blood collecting bag and blood component bag in a blood transfusion system, and for exchange of the dialyzing fluid bag and waste fluid bag in the continuous ambulatory peritoneal dialysis (CAPD), it is necessary to splice the tubes aseptically. Japanese Kokoku Patent No. Sho 61[1986]-30582 disclosed a type of device for performing such aseptic splicing for tubes. The device disclosed in this Japanese Kokoku Patent No. Sho 61[1986]-30582 is a tube splicing device in which tubes are heated and melted for splicing. As an example of the conventional aseptic splicing device, Figure 18 illustrates the mechanism. Splicing device (100) shown in Figure 18 has the following means: first clamp (111) and second clamp (110) that hold the two flexible tubes (115) and (116) to be spliced parallel to each other, cutting means (wafer) (114) for cutting the flexible tubes between first clamp (111) and second clamp (110), driving means (113) which moves the first clamp so that the end portions of the flexible tubes cut by the cutting means for splicing are arranged facing each other via the wafer, and driving means (112) which moves cutting means (114) upward to have the flexible tubes melted and cut and then moves the wafer downward after cutting.

[0003]

In this aseptic splicing device, after the thin plate-shaped wafer (114) is heated, it is moved from below upward between first clamp (111) and second clamp (110) to melt and cut flexible tubes (115) and (116) between the first and second clamps; then, first clamp (111) is moved backward (retracted) so that the cut end portions of the flexible tubes for splicing are arranged to face each other. Then, the wafer is moved downward, leaving the end portions of the flexible tubes for splicing bonded to each other.

[0004]

Problems to be solved by the invention

In the aforementioned splicing device, after tubes (115) and (116) are cut between first clamp (111) and second clamp (110) by wafer (114), first clamp (left-side clamp) (111) retreats, and the tubes to be spliced are moved to the position where they are arranged facing each other via wafer (114). Then, heated wafer (114) is moved downward, and the tubes to be spliced are arranged facing each other. Then, first clamp (left-side clamp) (111) is moved to the side of second clamp (right-side clamp) (110), and the tubes to be spliced are bonded to each other. Consequently, for the aseptic splicing device, second clamp (right-side clamp) (110) is always fixed on fixed table (118). First clamp (111) makes two movements, namely, the back-and-forth movement, and the movement towards the second clamp and then back in the lateral direction.

That is, for the same clamp, it is necessary to make movements in opposite directions, although not at the same time. This constitution may hamper the correct movement of the clamp, cause error in the movement of the clamp, and defective splicing of tubes caused by the error.

[0005]

In addition, the constitution is such that first clamp (111) makes two movements, namely, the back-and-forth movement, and the movement towards the second clamp (110) and then back in the lateral direction. That is, for the same clamp, it is necessary to make movements in opposite directions, although not at the same time. Consequently, when first clamp (111) is moved parallel to second clamp (110) so that the end portions of the flexible tubes cut by the cutting means are arranged facing each other, even when first clamp (111) is pushed, the first clamp moves little, and no gap can be formed between first clamp (111) and second clamp (110). Also, as explained above, said second clamp (110) is fixed. Consequently, it does not move. Consequently, it is hard to wipe off the residual material from the tube made of flexible resin attached to the inner surface of first clamp (111) and second clamp (110).

[0006]

The purpose of this invention is to solve the aforementioned problems of the conventional methods by providing a type of aseptic splicing device for flexible tubes characterized by the following facts: it makes the two movements, namely, the back-and-forth movement of the first clamp and the movement towards the second clamp and then backward in the lateral direction, smoothly; it is possible to ensure correct movement of the clamps; the error of the movement of the clamps can be reduced; splicing of the tubes can be carried out reliably; in addition, in the state when the first clamp has been moved parallel to the second clamp so that the end portions of the flexible tubes cut by the cutting means for splicing are arranged facing each other, a gap can be formed between the first clamp and the second clamp so that it is easier to perform the cleaning operation to wipe off the forming material of the tubes made of flexible resin attached to the inner surfaces of first clamp (111) and second clamp (110).

[0007]

In order to realize the aforementioned purpose, this invention provides an aseptic splicing device for flexible tubes characterized by the following facts: the device is for aseptically splicing flexible tubes; the device has the following parts: a first clamp and a second clamp for keeping at least two flexible tubes in a parallel configuration; a cutting means set between said first and second clamps for cutting said flexible tubes; a first driving mechanism which drives said first clamp parallel with respect to said second clamp so that the end portions cut by said

cutting means for splicing are arranged facing each other; a second clamp driving mechanism which drives said second clamp towards or away from said first clamp; and a cutting means driving means which drives said cutting means vertically between said first clamp and second clamp; in addition, as said first clamp is driven by the first clamp driving mechanism to move parallel to said second clamp so that the end portions cut by said cutting means for splicing are arranged facing each other, said second clamp driving mechanism can move the second clamp away from said first clamp by pushing said second clamp.

[0008]

Said first and second clamps hold at least two flexible tubes in a parallel configuration, and they hold the flexible tubes and squash the tubes; in addition, said second clamp driving mechanism has a pressing member which pushes said second clamp towards the side of said first clamp, and the pressing member preferably has a structure such that when first and second clamps hold the two flexible tubes and squash the tubes, the pressure of the pressing member is weaker than the repulsive force of the flexible tubes, and when the flexible tubes are held, the second clamp is moved a little away from the first clamp.

[0009]

It is preferred that said first clamp driving mechanism have a linear table for the first clamp to make a parallel movement with respect to said second clamp. In addition, it is preferred that said second clamp driving mechanism have a linear table for the second clamp to make a movement towards or away from said first clamp.

[0010]

In the following, the aseptic splicing device for flexible tubes of this invention will be explained with reference to figures. This aseptic splicing device (1) for flexible tubes has first clamp (3) and second clamp (2) for keeping at least two flexible tubes (48) and (49) parallel to each other, cutting means (5) for cutting flexible tubes (48) and (49) between first clamp (3) and second clamp (2), a first clamp driving mechanism which drives first clamp (3) to make a parallel movement with respect to the second clamp so that the splicing end portions of flexible tubes (48) and (49) cut by cutting means (5) are arranged facing each other, a second clamp driving mechanism which drives second clamp (2) towards or away from first clamp (3), and a cutting means driving means which drives cutting means (5) vertically between first clamp (3) and second clamp (2); the second clamp driving mechanism can drive second clamp (2) away from first clamp (3) in the state when first clamp (3) has been moved parallel to second clamp (2) such that the splicing end portions of the flexible tubes cut by cutting means (5) are arranged

facing each other. Also, for said aseptic splicing device (1), first clamp (3) and second clamp (2) are used to hold two flexible tubes (48) and (49) and squash the flexible tubes. Also, second clamp moving mechanism has pressing member (33) that pushes second clamp (2) to the side of first clamp (3). In addition, pressing member (33) has a structure such that when the two flexible tubes are held and squashed by first clamp (3) and second clamp (2), the pressure of pressing member (33) is weaker than the repulsive force of the flexible tubes, and, when the flexible tubes are held, second clamp (2) is moved a little away from first clamp (3).

[0011]

Figure 1 is an oblique view illustrating an application example of the aseptic splicing device for flexible tubes in this invention. Figure 2 is an oblique view illustrating the aseptic splicing device shown in Figure 1 when it is accommodated in a case. Figure 3 is a block diagram illustrating an example of the electrical circuit used in the aseptic splicing device of this invention. Figure 4 is an top view of an application example of the aseptic splicing device for flexible tubes of this invention. In this application example, aseptic splicing device (1) can be explained with reference to Figures 1, 2, 3, and 4. The operation of the first clamp, second clamp and the cutting means can be explained with reference to Figure 6. The operation of the first clamp can be explained with reference to Figure 7. The operation of the cutting means may be explained with reference to Figure 8. Also, the operation of the first and second clamps may be explained with reference to Figure 9, which is an oblique view.

[0012]

In the following, the overall structure of aseptic splicing device (1) will be explained. As shown in Figures 1, 2 , 4 and 9, said aseptic splicing device (1) has first clamp (3) and second clamp (2) which hold at least two flexible tubes in a parallel configuration. There are the following parts: gear (30) driven to rotate by a motor; gear (31) driven to rotate by rotation of gear (30); shaft (32) driven to rotate by rotation of gear (31); frame (9) which can fix the two ends of the shaft; inhibiting member (11) for inhibiting first clamp (3) from rattling at the origin position; microswitches (13), (14), and (15); driving arm (18) for driving first clamp (3) to move; cam (19) for moving first clamp (3); cutting means (5), cam (17) for driving cutting means (5) and the second clamp; pressing member (33) for pushing second clamp (2) towards the first clamp; stop (25) which restricts the retreated position of first clamp (3); spring member (27) for preventing rattling of first clamp (3); wafer replacement lever (22); wafer cartridge (8); wafer cartridge replacement lever (24); holding member (28) for used wafer storage box; guiding member (26) for guiding the used wafer into the storage box; used wafer storage box (29); and operation panel (50).

[0013]

Also, as shown in Figure 3, aseptic splicing device (1) in this application example also has the following parts: wafer heating constant-voltage power source (43) which has rectifying power source circuit (41) that converts AC to DC of the prescribed voltage; motor (42) which is also supplied with power from said constant-voltage power source (43); controller (40) for controlling motor (42) and wafer heating controller (44); wafer (6) for cutting the flexible tubes by heating and melting; temperature detecting means (7) for wafer (6); and wafer heating controller (44) which controls heating of wafer (6) by controlling the power supplied from constant-voltage power source (43) to wafer (6) on the basis of the signal from temperature detecting means (7). Also, as shown in Figure 5, there is connecting terminal (9) for electrical connection between constant-voltage power source (43) and the wafer. Reset switch (69) for resetting the device after the wafer short-circuit operation is electrically connected to wafer heating control means (44). Also, wafer heating control means (44) is electrically connected to controller (40). Controller (40) has the following parts: microswitch SW1 (13), microswitch SW2 (14), microswitch SW3 (15), microswitch SW4 (72), microswitch SW5 (73), microswitch SW6 (74), power source switch (51) placed on input panel (50), start switch (52), and buzzer (45) which is electrically connected to clamp set switch (53) and is turned ON upon a signal output from controller (40). Motor (42) is a driving source for driving cutting means (5), first clamp (3) and second clamp (2).

[0014]

Said aseptic splicing device (1) has a first clamp driving mechanism which moves first clamp (3) so that end portions (48a) and (49a) of flexible tubes (48) and (49) cut by cutting means (5) for splicing are arranged facing each other, and a second clamp driving mechanism which has the function is moving cutting means (5) towards the tubes (upward) and then moving it away from the tubes (downward) after cutting, and which drives said second clamp (2) towards or away from first clamp (3). The cutting means driving mechanism moves cutting means (5) upward and perpendicular to the axis of the two tubes, and it moves the cutting means downward after the tubes are cut. After cutting of the tubes, the first clamp driving means moves the first clamp (3), which is arranged horizontally with respect to the axis of the two tubes, in the perpendicular direction (or more specifically, backward), and the second clamp driving mechanism moves second clamp (2), which is arranged horizontally with respect to the axis of the two tubes, and moves a little in the parallel direction towards the first clamp.

[0015]

In the following, first clamp (3) and second clamp (2) will be explained. Said first clamp (3) and second clamp (2) have the structure shown in Figures 1, 4, 6 and 9. More specifically, as shown in Figure 9, first clamp (3) has base (3b), cover (3a) attached on base (3b) in a rotatable manner, and clamp fixing table (3c) on which base (3b) is fixed. Also, said clamp fixing table (3c) is fixed on the linear table. The linear table is composed of moving table (3c)[sic; (3d)] fixed on the lower surface of clamp fixing table (3c), and rail member (3n) set on the lower portion of moving table (3c). By means of said linear table, first clamp (3) is moved free of error in the direction perpendicular to the axis of tubes (48) and (49) to be spliced, in other words, to make the end portions of the flexible tubes that have been cut for splicing face each other. Consequently, in aseptic splicing device (1) in this application example, the first clamp driving mechanism is composed of said linear table, a motor, gear (30), gear (31) shaft (32), driving arm (18), and cam (19). In this splicing device (1), as shown in Figures 1 and 4, spring member (27) is arranged to connect the rear side of first clamp fixing table (3c) and the frame of splicing device (1), and first clamp (3) is normally pulled backward under tension, so that first clamp (3) (or, more correctly, first clamp fixing table (3c)) has little rattle. Also, as shown in Figures 1 and 4, at the tube mounting position of first clamp (3) (in other words, at the position where the first clamp is in its front most state), inhibiting member (11) for inhibiting rattle of first clamp (2) is fixed on the side surface of frame (9). Consequently, at the tube installing position, first clamp (3) is pulled under tension by spring member (27). Consequently, there is no rattle on the rear side. Also, by means of a rattle inhibiting member on the front, there is no way to move forward. Consequently, first clamp (3) has a structure that permits no rattle at the tube installing position. Also, as shown in Figures 1 and 4, on splicing device (1), stop (25) that restricts the maximum movement to the rear of first clamp (3) (or more correctly, first clamp fixing table (3c)) is arranged.

[0016]

As shown in Figures 4, 6 and 9, second clamp (2) has base (2b), cover (2a) mounted on base (2b) in a rotatable manner, and clamp fixing table (2c) on which base (2b) is fixed. Said clamp fixing table (2c) is fixed on a linear table. The linear table is composed of moving table (2c) [sic; (2d)] fixed on the lower surface of clamp fixing table (2c) and rail member (2n) set on the lower portion of moving table (2c). By means of this linear table, second clamp (2) can be moved free of error in the direction parallel to the axis of tubes (48) and (49), in other words, second clamp (2) can be moved only in the direction towards or away from first clamp (3).

[0017]

As shown in Figures 4 and 6, pressing member (33) is positioned between the frame of splicing device (1) and clamp fixing table (2c), and it constantly pushes second clamp (2) (or more correctly, second clamp fixing table (2c)) towards the first clamp. A spring member may be preferably used as the pressing member. Said pressing member (33) has a structure such that when first clamp (3) and second clamp (2) hold two flexible tubes (48) and (49) and squash the tubes, the pressure of pressing member (33) is weaker than the repulsive force of the flexible tubes, and when the flexible tubes are held, second clamp (2) is moved a little bit away from first clamp (3). Consequently, for aseptic splicing device (1) in this application example, said second clamp driving mechanism is composed of said linear table, motor, gear (30), gear (31), shaft (32), cam (17), and pressing member (33).

[0018]

As shown in Figure 9, first clamp (3) and second clamp (2) have a structure such that they hold the tubes as the tubes are obliquely pushed and squashed. Clamps (3) and (2) have covers (3a) and (2a) which are mounted in a rotatable manner on bases (3b) and (2b), respectively. On bases (3b) and (2b), there are two slots (3f), (3e) and (2f), (2e) set parallel to each other for carrying the two tubes, respectively. On the end surfaces of bases (3b) and (2b) of the portions of slots (3f), (3e) and slots (2f), (2e) facing each other, sawtooth-shaped closing members (3h) and (2h) are set, respectively. On covers (3a) and (2a), sawtooth-shaped closing members (3g) and (2g) corresponding to closing members (3h) and (2h) of said bases (3b) and (2b) are arranged, respectively. The inner surfaces of covers (3a) and (2a) are flat. Also, covers (3a) and (2a) have rotating cams, respectively. As said rotating cams close covers (3a) and (2a), engagement is made with the rollers of bases (3b) and (2b). For the two tubes, when covers (3a) and (2a) are closed, the portion between closing member (3h) of base (3b) and closing member (3g) of cover (3a), and the portion between closing member (2h) of base (2b) and closing member (2g) of cover (2a) are obliquely squashed, and the closed state is maintained. Also, first clamp (3) has bump portion (3i) that projects towards the second clamp, while second clamp (2) has dip portion (2i) for accommodating said bump portion (3i). Consequently, second clamp (2) has a structure such that when first clamp (1) is not closed, it cannot close.

[0019]

As shown in Figure 1, aseptic splicing device (1) has gear (30) rotated by a motor and gear (31) rotated by rotation of said gear (30). As shown in Figure 6, two cams (19) and (17) are fixed on shaft (32) of gear (31). Cams (19) and (17) rotate together with rotation of gear (31). On the right-side surface of cam (19), cam groove (19a) for driving the first clamp and having a

shape shown in Figure 7 is formed. Also, there is arm (18) for moving the first clamp and having follower (18a) that slides in cam groove (19a) of cam (19) at its center. Also, the lower end of arm (18) is supported in a rotatable manner on frame (9) by supporting point (18b). The upper end of arm (18) is supported in a rotatable manner by supporting point (18c) set on clamp fixing table (3c). Consequently, as shown in Figure 7, when cam (19) rotates, first clamp (3) moves along rail member (3n) of the linear table and following the profile of cam groove (19a), as indicated by the arrow to the rear side in the orthogonal direction while it is horizontal with respect to the axis of the two tubes.

[0020]

As shown in Figure 5, cutting means (5) has wafer holding unit (5a) that can hold the wafer in an replaceable manner, arm unit (5c) set below wafer holding unit (5a), follower (5b) set on the end portion of arm unit (5c), hinge unit (5d), and mounting unit (5e) for mounting on frame (9). By means of hinge portion (5d), it can rotate with respect to frame (9). As shown in Figure 5, on the right side surface of cutting means (5), electrical connecting terminal (9) for heating the wafer and temperature detecting means (7) for detecting the wafer temperature are fixed. It is preferred that a thermocouple or a temperature measuring resistor be used as said temperature detecting means (7). More preferably, a sheet-shaped thermocouple or temperature measuring resistor is used. In particular, the sheet-shaped thermocouple is preferred. Wafer (6) preferably is composed of a folded metal sheet, an insulating layer formed on the inner surface of the metal sheet, a resistor formed in the insulating layer without contact with said metal sheet, and terminals set on the two end portions of the resistor for feeding power.

[0021]

As shown in Figures 5 and 8, cam (17) has cam groove (17a) for driving the cutting means formed on its left side surface. Follower (5b) of cutting means (5) is positioned in cam groove (17a) of cam (17), and it slides in cam groove (17a) along the profile of the cam groove. Consequently, as shown in Figure 8, as cam (17) is rotated, cutting means (5) moves vertically following the profile of cam groove (17a); that is, it moves vertically in the direction orthogonal and perpendicular to the axis of the two tubes. In addition, as shown in Figure 6, cam (17) has cam groove (17c) in the central portion for driving second clamp (2). Cam groove (17c) has left side surface (17f) and right side surface (17e). By means of left side surface (17f) and right side surface (17e), the position of the second clamp is controlled. Said clamp fixing table (2c) has a bump portion that extends downward, and follower (20) is set on its tip. Said follower (20) slides in cam groove (17c) for driving second clamp (2). Then, as shown in Figure 6, a certain gap is formed between follower (20) and cam groove (17c). As second clamp fixing table (2c) is

constantly pushed by spring member (33), in the normal state, follower (20) is in contact with left side surface (17f) of cam groove (17c), and there is a certain gap between follower (20) and right side surface (17e) of cam groove (17c). However, as the two tubes are held by first clamp (3) and second clamp (2), as explained above, two clamps (3) and (2) hold the two tubes as the tubes are squashed and kept closed. Consequently, a repulsive force develops due to closure of the tubes. As spring member (33) has a force smaller than the repulsive force caused by said closure of the tubes, as shown in Figure 6, in the state with clamps (3) and (2) holding the tubes, follower (20) is in contact with right side surface (17e) of cam groove (17c), and there is a certain gap between follower (20) and left side surface (17f) of cam groove (17c). However, as said tubes are cut by said cutting means (2), the repulsive force caused by closure of the tubes disappears, so that it returns to the normal state, follower (20) comes in contact with left side surface (17f) of cam groove (17c), and there is a certain gap between follower (20) and right side surface (17e) of cam groove (17c). In this way, due to the function of spring member (33) and the repulsive force of the tubes, the sliding surface of the cam groove that is in contact with follower (20) varies over time.

[0022]

As shown in Figure 6, dip portion (17d) is formed on left side surface (17f). When follower (20) passes through this dip portion (17d), the tubes have been cut by the cutting means. Consequently, follower (20) slides along left side surface (17f) of cam groove (17). As a result, follower (20) enters the dip portion (17). Consequently, second clamp (2) moves in the direction towards first clamp (3) by a distance corresponding to the depth of dip portion (17d). In this way, splicing of the tubes can be performed reliably.

[0023]

Dip portion (17g) is formed on right side surface (17e) of cam groove (17c). This dip portion (19) is for cleaning the inner surface of clamps (3) and (2). By setting dip portion (17g), by pushing second clamp (2) towards spring member (33), second clamp (2) is moved away from first clamp (3) until follower (20) comes in contact with dip portion (17g). In this way, a gap is formed between first clamp (3) and second clamp (2). The interior of the gap formed can be cleaned by a cotton swab impregnated with a solvent, such as alcohol, that can dissolve the material that forms in the tubes that have been cut. As shown in Figure 6, said dip portion (17g) is set at a position nearly facing dip portion (17d) (the portion for second clamp (2) to perform lateral shifting) on left side surface (17f). When follower (20) set on the bump portion projecting downward from second clamp fixing table (2c) enters dip portion (17d), after the tubes are cut, the targeted tubes are spliced to each other. In this state, the second clamp is stopped. Also, the

first clamp is stopped, and first clamp (3) is at a position deviated [front to back] from the second clamp. More specifically, as shown in Figure 1, first clamp (3) retreats from second clamp (2), and first clamp (3) is at a position deviated from the second clamp. Consequently, in this state, the inner surface of the tip portion of second clamp (2) is exposed a little, and the inner surface of the rear end portion of the first clamp is also exposed a little. Consequently, cleaning becomes easy for the exposed inner surface of second clamp (2) and first clamp (3). The depth of dip portion (17g) should be in the range of 1-10 mm, or preferably in the range of 2-8 mm.

[0024]

In the following, the function of aseptic splicing device (1) of this invention will be explained with reference to figures. Figure 10 is a timing chart illustrating the operation of the first clamp and the second clamp. Figures 11, 12 and 13 are flow charts illustrating the function of the aseptic splicing device. Figures 14, 15 and 16 illustrate the function of the aseptic splicing device. For this splicing device (1), at the end of the splicing operation, first clamp (3) is at a position deviated from second clamp (2), that is, at the stop position of the timing chart shown in Figure 10. For the timing chart shown in Figure 10, the angle represented by the ordinate is 0° at the origin (the state in which the first clamp and the second clamp meet each other), and the figure illustrates the movement of the cutting means (wafer), first clamp (3) and second clamp (2) at the angle of rotation of shaft (32) of gear (31), that is, the angle of rotation of cam (17) and cam (19).

[0025]

First, as shown in the flow sheet chart in Figure 11, power source switch (51) set on panel (50) shown in Figure 3 is pushed. In this way, by means of the CPU that forms controller (40) shown in Figure 3, splicing device (1) determines whether there is no abnormality (more specifically, whether there is no internal connector detachment, broken thermocouple wire, or poor internal power source voltage). If an abnormality is found, the buzzer is turned on. Then, clamp reset switch (53) set on panel (50) shown in Figure 3 is pushed. Then, by means of the CPU, determination is made whether the first and second clamps are opened, whether the first and second clamps are at the origin, and whether the wafer replacement lever is at the origin. As explained above, for the clamps used in aseptic splicing device (1) in this application example, said first clamp (3) has bump portion (3i) projecting towards the second clamp, and second clamp (2) has dip portion (2i) for accommodating said bump portion (3i). Consequently, the structure is such that if first clamp (1) is not closed, second clamp (2) cannot be closed. Consequently, the opening state of the first and second clamps is detected by contact lever (16) and microswitch (13) that is turned ON/OFF by said lever (16) when the second clamp is closed.

More specifically, when the second clamp is in the released state, microswitch (13) is OFF, and, when second clamp (2) is closed, it makes contact with lever (16), lever (16) moves, and microswitch (13) is turned ON. The ON/OFF signal of said microswitch (13) is input to controller (40). The state when the first and second clamps are not at the origin is determined as the grooves formed on the circumference of the cams are detected by microswitches SW5 (73) and SW6 (74). The state when wafer replacement lever (22) is at the origin is detected by microswitch (14). When lever (22) is at the origin, microswitch (14) is ON. When it is not at the origin, the microswitch is OFF. The ON/OFF signal of said microswitch (14) is input to controller (40).

[0026]

As shown in Figure 11, when all of the aforementioned four determinations are YES, the motor is turned ON, and the first and second clamps are reset to the origin. On the other hand, when one of said four determinations is NO, the buzzer is turned ON, the abnormality-indicating lamp is lit, and manual release is carried out by pushing the reset switch so as to turn off the abnormality-indicating lamp. After the first and second clamps reach the origin, two flexible tubes (48) and (49) are installed in the first and second clamps. In this state, as shown in Figure 9, both first and second clamps (3) and (2) are opened, and slots (3e) and (2e) as well as (3f) and (2f) formed on them face each other. Then, tube (49) in use is installed in front slots (3f) and (2f), while connected unused tube (48) is installed in rear slots (3e) and (2e).

[0027]

After said first clamp and second clamp (3)[sic, first clamp (3) and second clamp (2)] are closed, wafer replacement lever (22) is pushed towards the clamp, and the wafer is replaced. By pushing wafer replacement lever (22) towards the clamp, the new wafer is removed from the interior of wafer cartridge (8), and the new wafer is used to push the stand-by wafer installed on cutting means (5), and the stand-by wafer pushes the used wafer installed on cutting means (5), so that while the stand-by wafer is installed in the use position, the used wafer is stored in used wafer storage box (29). Then, as start switch (52) on panel (50) is pushed, the sequence goes to step ② in the flow chart shown in Figure 12. By means of the CPU that forms controller (40) shown in Figure 3, whether the first and second clamps are closed, whether the wafer has been replaced, whether the first and second clamps are at the origin, whether the wafer replacement lever is at the origin, and whether the first and second clamps are closed are detected by lever (16) that comes in contact with the second clamp when it is closed, and microswitch (13) which is turned ON/OFF by said lever (16). More specifically, when second clamp (2) is in the released state, microswitch (13) is OFF; when second clamp (2) is closed, it makes contact with lever

(16), lever (16) moves, and microswitch (13) is turned ON. The ON/OFF signal of microswitch (13) is input to controller (40). Whether the wafer has been replaced or not is detected as follows: as wafer replacement lever (22) is pushed towards the clamps, and the wafer replacement operation is carried out, replacement lever (22) turns microswitch (15) ON, so that whether replacement has been made is detected by the ON signal from microswitch (15). The ON/OFF signal of micro signal (15) is input to controller (40). Whether the first and second clamps are at the origin is detected by microswitches (5) and (6) as explained above.

[0028]

As shown in Figure 12, when any one of the aforementioned four determinations is NO, the buzzer is turned ON, and the sequence goes back to ③ in Figure 11. On the other hand, when all of the aforementioned four determinations are YES, operation-indicating lamp (47) is turned ON, and heating of the wafer is started. After start of heating of the wafer, determination is made whether the wafer current is higher than a prescribed level. This determination is made to ascertain whether a wafer short-circuit has taken place. If it is found that the wafer current is not lower than the preset level (that is, when the voltage applied to the shunt resistor is higher than a prescribed level), after waiting for 0.3 sec, determination is made again whether the wafer current is within the prescribed range. When use of the wafer has been completed, the resistance value decreases due to the thermal history of the resistor. Consequently, the wafer current is measured and compared with a preset wafer current to determine whether it is within the preset range (tolerable range). In this way, whether use of the wafer has been completed is judged electrically. If the aforementioned wafer current is higher than the present level (a wafer short-circuit occurs when) and when the aforementioned wafer current is not within the preset range (when use of the wafer has been completed), the buzzer is turned ON, heating of the wafer is stopped, the wafer abnormality-indicating lamp is turned ON. After the reset switch is pushed, the sequence goes to step ⑤ in the flow chart shown in Figure 11. Then, wafer current comparison is made. If the wafer current is found to be within the preset range (the tolerable range), heating of the wafer is continued. Heating of wafer (6) is carried out under control of constant-voltage power source (43) by means of the pulse width modulation signal calculated on the basis of the output of temperature detection thermocouple (7), which is the means for detecting the temperature of the wafer. In order to prevent excessive heating of the wafer, determination is made whether the heating time of the wafer is within a prescribed time. Also, determination is made whether the wafer current is lower than a prescribed level. If it is lower than the prescribed level, that is, when a wafer short-circuit accident takes place, the buzzer is turned ON immediately, and heating of the wafer is turned OFF. The sequence then goes to step ⑤ in the flow chart shown in Figure 11. Then, as the temperature of the wafer reaches the preset

temperature, the sequence goes to step ④ in the flow chart shown in Figure 13, and the motor is turned ON. In this way, gears (30) and (31) and cams (19) and (17) are rotated, the cutting means (wafer) is raised so that cutting of tubes, retreat of the first clamp, lowering of the cutting means (wafer), and lateral shifting of the second clamp towards the first clamp are carried out.

[0029]

Then, as shown in the flow chart in Figure 13, lifting of the wafer, cutting of tubes, retreat of the first clamp, and lowering of the wafer are performed in order. More specifically, first, as cam (17) is rotated in the direction indicated by the arrow, follower (5b) of cutting means (5) slides in cam groove (17a). The state changes from the initial state in which origin O of the cam groove is in contact with follower (5b) as shown in Figures 8 and 10 to the state in which point A of cam groove (17a) is in contact with follower (5b) as shown in Figures 8 and 10. Then, as shown in Figures 8 and 10, during the process when the state changes from that in which point A of cam groove (17a) is in contact with follower (5b) to that in which point B of cam groove (17a) is in contact with follower (5b), cutting means (5) is raised gently as shown in Figure 10, and the two flexible tubes are cut in this rising process. Explanation can be made with reference to Figures 14 and 15. Two tubes (48) and (49) are held by first clamp (3) and second clamp (2), tube portions (48a) and (49a) are formed between first clamp (3) and second clamp (2), and wafer (6) as the cutting means is positioned below them. As explained above, as cam (17) is rotated, cutting means (5) (wafer (6)) is raised, so that, as shown in Figure 15, tube portions (48a) and (49a) of the two tubes positioned between first clamp (3) and second clamp (2) are melted and cut.

[0030]

Then, as shown in Figure 8, during the process when the state changes from that in which point B of cam groove (17a) is in contact with follower (5b) to that in which point C of cam groove (17a) is in contact with follower (5b), as shown in Figures 8 and 10, the raised state of cutting means (5) is maintained, and the cut end portions of tubes (48a) and (49a) are thoroughly melted. Then, during the process when the state changes from that in which point C of cam groove (17a) is in contact with follower (5b) as shown in Figures 8 and 10 to that in which point E of cam groove (17a) is in contact with follower (5b), as shown in Figures 8 and 10, cutting means (5) is gently lowered. Also, as shown in Figure 7, as cam (19) is rotated in the direction indicated by the arrow, follower (18a) formed on arm (18) for moving the first clamp slides in cam groove (19a). The state in which origin O of the cam groove is in contact with follower (18a) as shown in Figures 7 and 10 changes to the state in which point F of cam groove (19a) is in contact with follower (18a) as shown in Figures 7 and 10. As shown in the timing chart in

Figure 10, follower (18a) arrives at point F of cam groove (19a) a little earlier than follower (5b) of cutting means (5) reaches point B of cam groove (17a). As shown in Figures 7 and 10, during the process when the state changes from that in which point F of cam groove (19a) is in contact with follower (18a) to that in which point G of cam groove (19a) is in contact with follower (18a), as shown in Figure 10, first clamp (3) is retracted slowly to the state shown in Figure 16, and spliced tube portions (49a) and (48a) are arranged facing each other via wafer (6). As shown in the timing chart in Figure 10, this state is maintained during the period when the state changes from that in which point G of cam groove (19a) is in contact with follower (18a) to that in which point C of cam groove (17a) is in contact with follower (5b). Also, for the position of the second clamp, the state shown in Figure 16 is maintained during the period when the state changes from that in which point G is in contact with follower (18a) to that in which point H of cam groove (19a) is in contact with follower (18a). Also, as explained above, during the process when the state changes from that in which point C of cam groove (17a) is in contact with follower (5b) as shown in Figures 8 and 10 to that in which point E of cam groove (17a) is in contact with follower (5b), as shown in Figures 8 and 10, cutting means (5) is gently lowered, and tube portions (48a) and (49a) for splicing come in contact with each other.

[0031]

Then, almost at the same time that lowering descending of cutting means (5) comes to an end, that is, when point E of cam groove (17a) reaches the state in which it is in contact with follower (5b), as shown in Figures 6 and 10, second clamp (2) shifts laterally towards the first clamp. More specifically, as shown in Figures 6 and 10, during the process when the state changes from that in which point M on the left side surface (17d) of cam groove (17c) is in contact with follower (20) for driving second clamp (2) to that in which point L on the left side surface is in contact with follower (20), second clamp (2) is slowly moved towards first clamp (3). During the process of change of the state from that in which point LK of dip portion (17d) of cam groove (17c) is in contact with follower (20) to that in which point K of dip portion (17d) is in contact with follower (20), the lateral shifting state is maintained. Due to the lateral shifting, tube portions (48a) and (49a) are reliably in close contact with each other. Consequently, splicing of the two tubes can be carried out reliably. Then, during the process when the state changes from that in which point K of dip portion (17d) of cam groove (17c) is in contact with follower (20) to that in which point J on left side surface (17f) is in contact with follower (20), second clamp (2) is moved slowly away from first clamp (3), and, in this state, the motor is turned off.

[0032]

Consequently, as shown in Figure 17, when stopped, the positions of first clamp (3) and second clamp (2) become the same deviated positions as shown in Figure 16. Then, as shown by the flow chart in Figure 13, the wafer temperature is detected by a thermocouple. If the wafer temperature is lower than the present level, the operation lamp is turned off, and the buzzer is turned on. Then, as shown in Figure 17, first clamp (3) and second clamp (2) are opened, and the tubes are taken out. In this way, the splicing operation of the tubes comes to an end.

[0033]

In the state when the splicing operation comes to an end, second clamp and first clamp are stopped, and first clamp (3) is at a position deviated from the second clamp. Consequently, in this state, the inner surface of the tip portion of second clamp (2) is exposed a little, and the inner surface of the rear end portion of the first clamp is also exposed a little. Then, by observing the exposed inner surfaces of the first and second clamps, determination can be made on whether material for forming the tubes that have been cut is attached. When it is believed that material for forming the tubes is attached and will affect splicing of the tubes to be carried out in the next step of operation, second clamp (2) is pushed towards spring member (33) (in the direction away from first clamp (3)). In this way, second clamp (2) is moved away from first clamp (3) until follower (20) set on the bump portion projecting downward from second clamp fixing table (2c) comes in contact with dip portion (17g). In this way, a gap is formed between first clamp (3) and second clamp (2). In the gap formed in this way, it is possible to insert a cotton swab impregnated with alcohol or other solvent that can dissolve the tube-forming material to effect cleaning.

[0034]

Effects of the invention

This invention provides an aseptic splicing device for flexible tubes characterized by the following facts: the device is for aseptically splicing flexible tubes; the device has the following parts: a first clamp and a second clamp for keeping at least two flexible tubes in a parallel configuration; a cutting means set between said first and second clamps for cutting said flexible tubes; a first driving mechanism which drives said first clamp parallel with respect to said second clamp so that the end portions cut by said cutting means for splicing are arranged facing each other; a second clamp driving mechanism which drives said second clamp towards or away from said first clamp; and a cutting means driving means which drives said cutting means vertically between said first clamp and second clamp; in addition, as said first clamp is driven by the first clamp driving mechanism to move parallel to said second clamp so that the end portions cut by

said cutting means for splicing are arranged facing each other, said second clamp driving mechanism can move the second clamp away from said first clamp by pushing said second clamp. Consequently, the first clamp makes only a back-and-forth movement, and the second clamp makes only a movement towards or away from the first clamp. Consequently, it is possible to ensure correct movements of the clamps, respectively, it is possible to reduce error of the movement of the clamps, and it is possible to perform splicing of the tubes reliably. In addition, in the state in which the first clamp is moved parallel to the second clamp such that the end portions of the flexible tubes for splicing cut by the cutting means are arranged facing each other; that is, in the state when the first clamp and the second clamp have their positions deviated from each other, by pushing the second clamp, it is possible to move it away from the first clamp. Consequently, it is possible to form a gap between the first clamp and the second clamp, and it is easy to perform the cleaning operation to wipe off material for forming the flexible resin tubes that is attached to the inner surfaces of the first clamp and the second clamp.

Brief description of the figures

Figure 1 is an oblique view illustrating an application example of the aseptic splicing device for flexible tubes of this invention.

Figure 2 is an oblique view illustrating the state in which the aseptic splicing device shown in Figure 1 is accommodated in the case.

Figure 3 is a block diagram illustrating an example of the electrical circuit used in the aseptic splicing device of this invention.

Figure 4 is an upper view of an application example of the aseptic splicing device of this invention.

Figure 5 is a left side view of an example of the cutting means used in the aseptic splicing device of this invention.

Figure 6 is a diagram illustrating the operation of the first clamp, the second clamp, and the cutting means.

Figure 7 is a diagram illustrating the operation of the first clamp.

Figure 8 is a diagram illustrating the operation of the cutting means.

Figure 9 is an oblique view illustrating an example of the first and second clamps used in the aseptic splicing device of this invention.

Figure 10 is a timing chart illustrating the operational timing of the first clamp, the second clamp, and the cutting means.

Figure 11 is a flow chart illustrating the function of the aseptic splicing device of this invention.

Figure 12 is a flow chart illustrating the function of the aseptic splicing device of this invention.

Figure 13 is a flow chart illustrating the function of the aseptic splicing device of this invention.

Figure 14 is a flow chart illustrating the function of the aseptic splicing device of this invention.

Figure 15 is a flow chart illustrating the function of the aseptic splicing device of this invention.

Figure 16 is a flow chart illustrating the function of the aseptic splicing device of this invention.

Figure 17 is a flow chart illustrating the function of the aseptic splicing device of this invention.

Figure 18 is an oblique view illustrating a conventional aseptic splicing device for flexible tubes.

Brief description of part numbers

1	Aseptic splicing device
2	Second clamp
3	First clamp
3d	Moving table of the linear table
3h	Rail member of the linear table
33	Pressing member
5	Cutting means
6	Wafer
7	Wafer temperature detecting means
9	Electrical connecting terminal for heating of wafer
13	Microswitch 1
14	Microswitch 2
15	Microswitch 3
48	Tube
49	Tube
40	Controller
41	Rectifying power source circuit
42	Motor
43	Constant-voltage power source

44 Wafer heating control means

50 Input panel

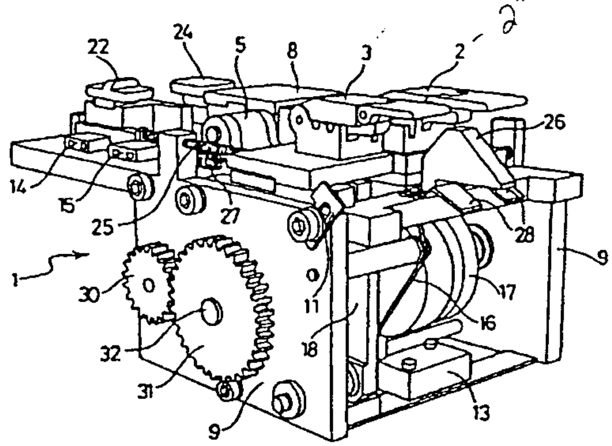


Figure 1

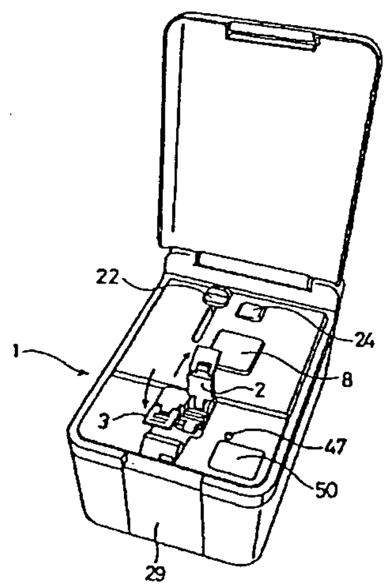


Figure 2

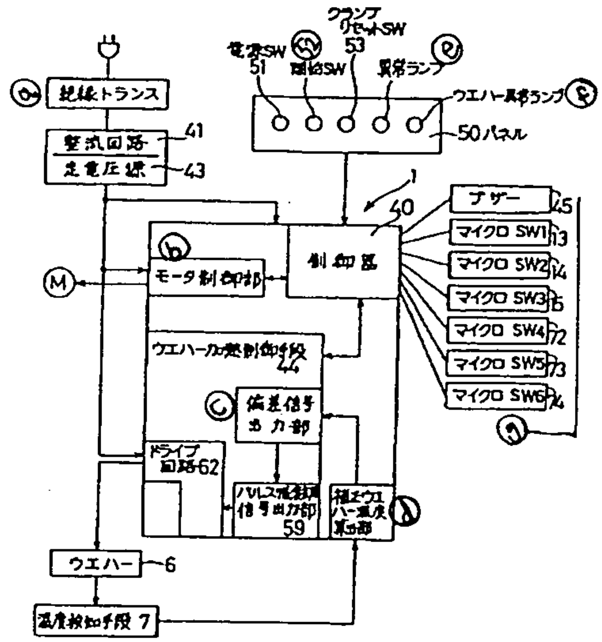


Figure 3

Key:
6 Wafer
7 Temperature detecting means
40 Controller
41 Rectifying circuit
43 Constant-voltage power source
44 Wafer heating control means
45 Buzzer
50 Panel
51 Power source SW
52 Start [switch] SW
53 Clamp set switch
59 Pulse width modulation signal output unit
62 Drive circuit
a Insulating transformer
b Motor control unit
c Error signal output unit
d Wafer temperature correction calculating unit
e Abnormality-indicating lamp
f Wafer abnormality-indicating lamp
g Microswitch SW

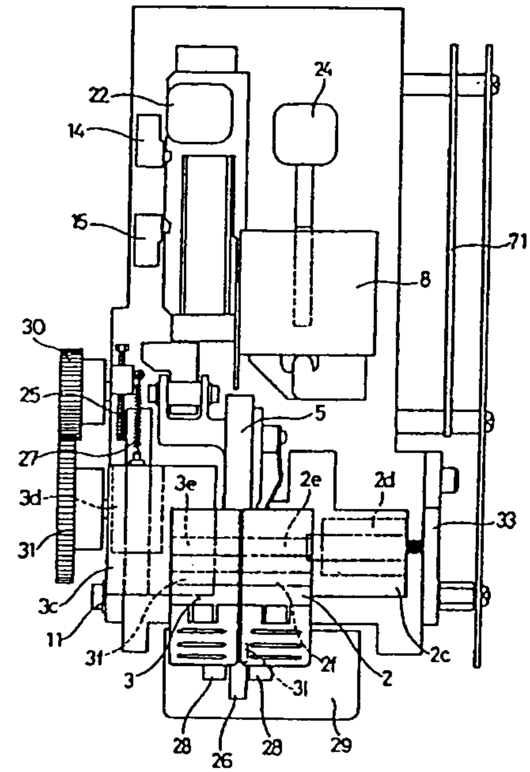


Figure 4

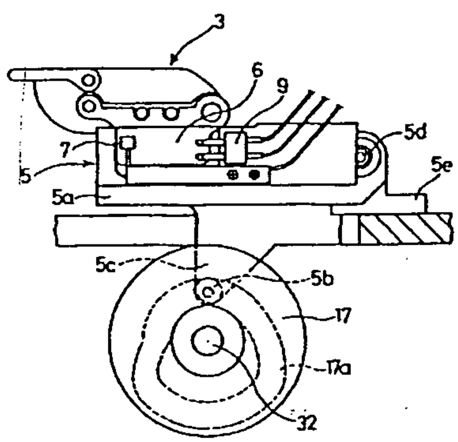


Figure 5

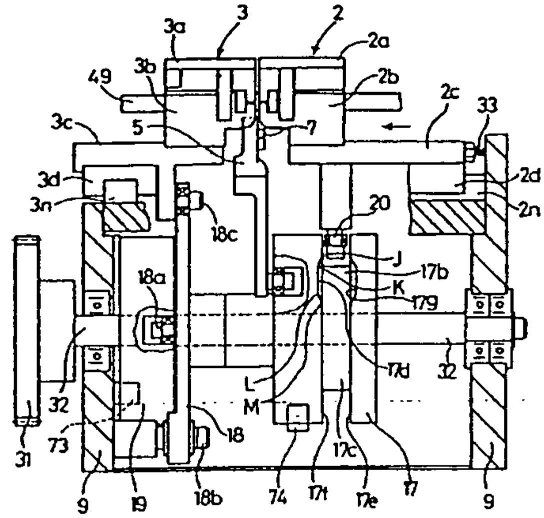


Figure 6

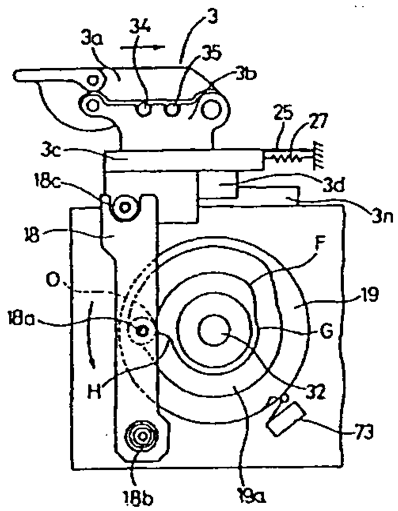


Figure 7

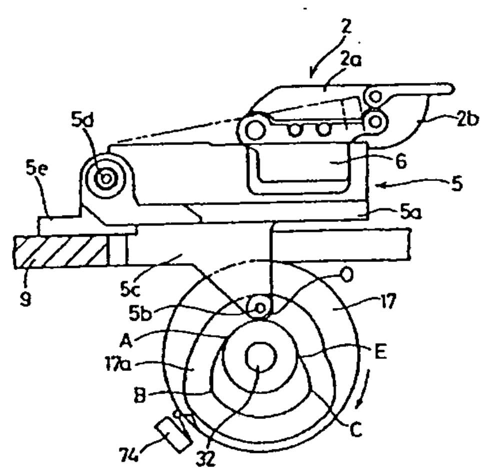


Figure 8

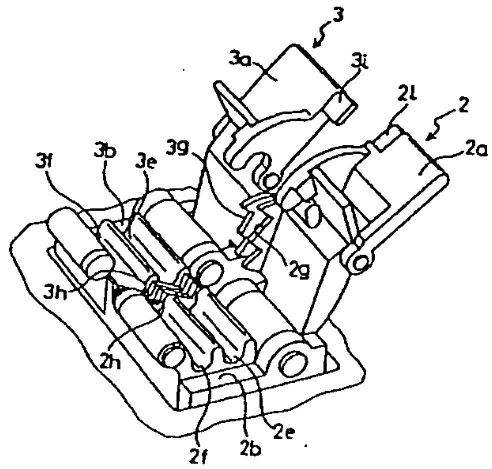


Figure 9

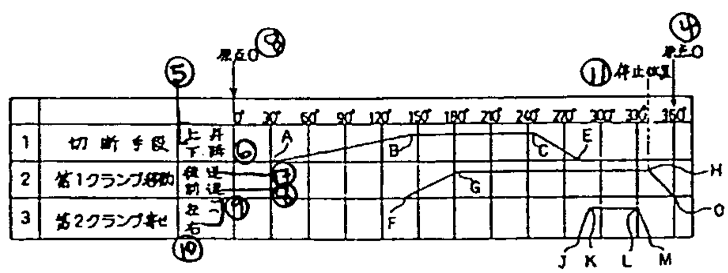
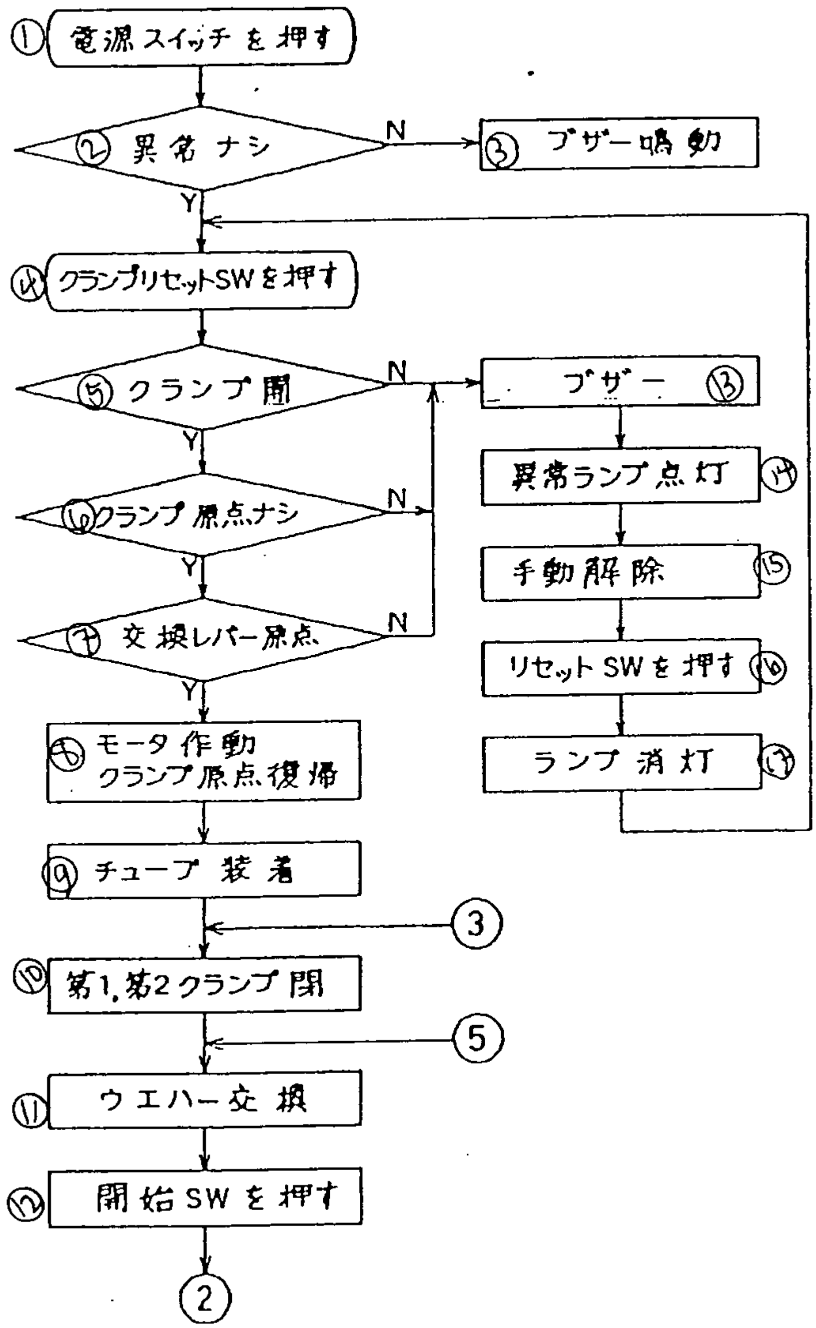


Figure 10

Key:
1 Cutting means
2 Movement of the first clamp
3 Shifting of the second clamp
4 Origin
5 Rise
6 Descend
7 Backward
8 Forward
9 To the left
10 To the right
11 Stop position



①電源スイッチを押す
②異常ナシ
N
③ブザー鳴動
Y
④クランプリセットSWを押す
⑤クランプ開
N
ブザー ⑬
Y
⑥クランプ原点ナシ
N
異常ランプ点灯 ⑭
Y
手動解除 ⑮
⑦交換レバー原点
N
リセットSWを押す ⑯
Y
⑧モータ作動
クランプ原点復帰
ランプ消灯 ⑰
⑨チューブ装着
3
⑩第1,第2クランプ閉
5
⑪ウエハー交換
⑫開始SWを押す
2

Figure 11

Key: 1	Power source switch is pushed
2	There is no abnormality?
3	Buzzer is turned on
4	Clamp reset SW is pushed
5	Is clamp open?
6	Clamp is not at origin
7	Replacement lever at origin
8	Motor is turned on, and clamp is returned to origin
9	Tubes are installed
10	First and second clamps are closed
11	Wafer is replaced
12	Start SW is pushed
13	Buzzer
14	Abnormality-indicating lamp is turned on
15	Manual release
16	Reset SW is pushed
17	Lamp is turned off

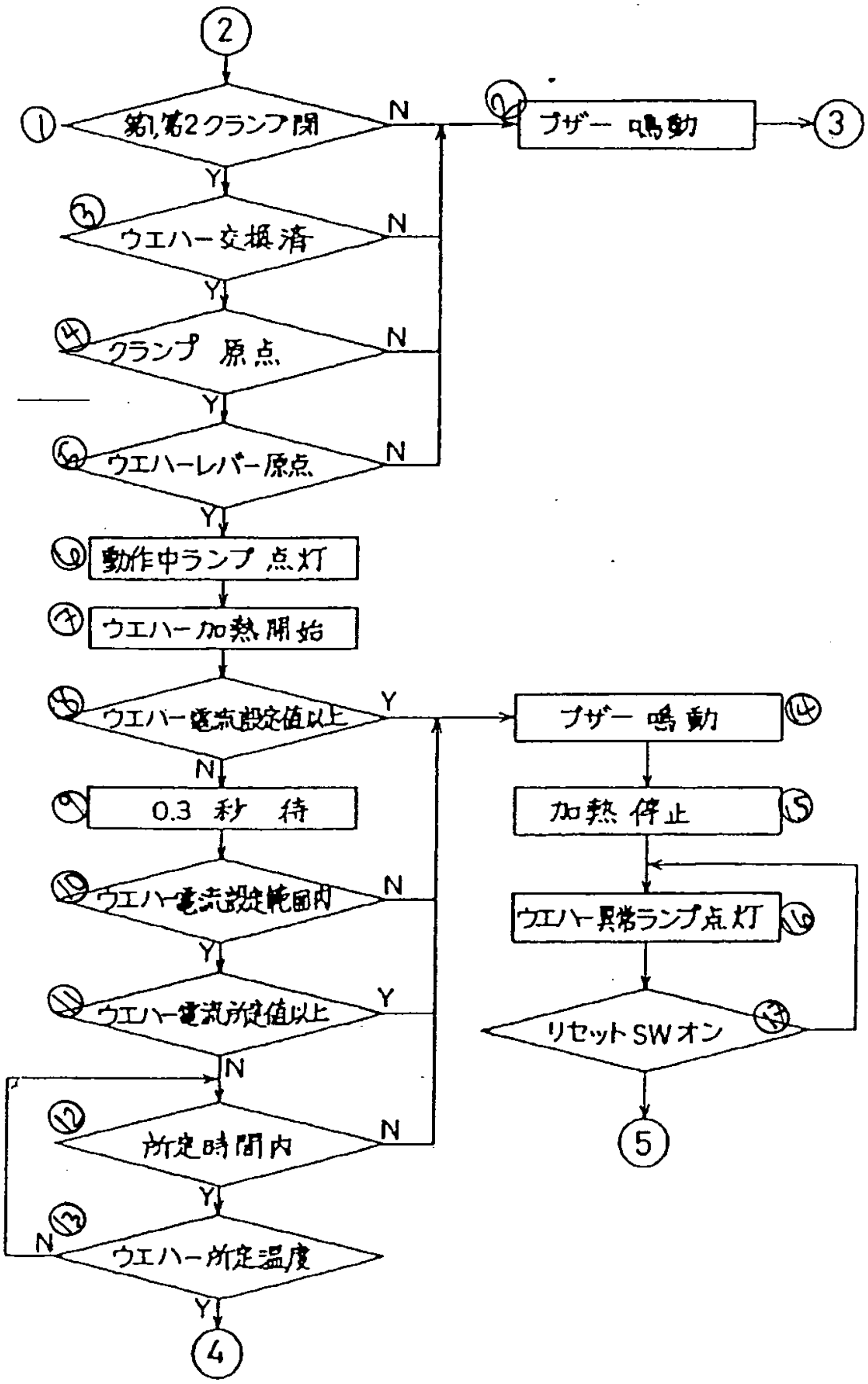

2
第1,第2クランプ閉
ブザー 鳴動
3
ウエハー交換済
クランプ 原点
ウエハーレバー原点
動作中ランプ 点灯
ウエハー加熱開始
ウエハー電流設定値以上
ブザー 鳴動
0.3 秒 待
加熱 停止
ウエハー電流設定範囲内
ウエハー異常ランプ点灯
ウエハー電流所定値以上
リセット SW オン
所定時間内
5
ウエハー所定温度
4
Y
N

Figure 12

Key:

1	Are the first and second clamps open?
2	Buzzer is turned on
3	End of wafer replacement
4	Clamp origin?
5	Wafer lever origin?
6	Operation-indicating lamp is turned on
7	Start of wafer heating
8	Is the wafer current higher than the preset level?
9	Wait for 0.3 sec
10	Is the wafer current within the preset range?
11	Is the wafer current higher than the preset level?
12	Is the time shorter than the prescribed time?
13	Is the wafer at the prescribed temperature?
14	Buzzer is turned on
15	Heating is stopped
16	Wafer abnormality-indicating lamp is turned on
17	Is the reset SW on?

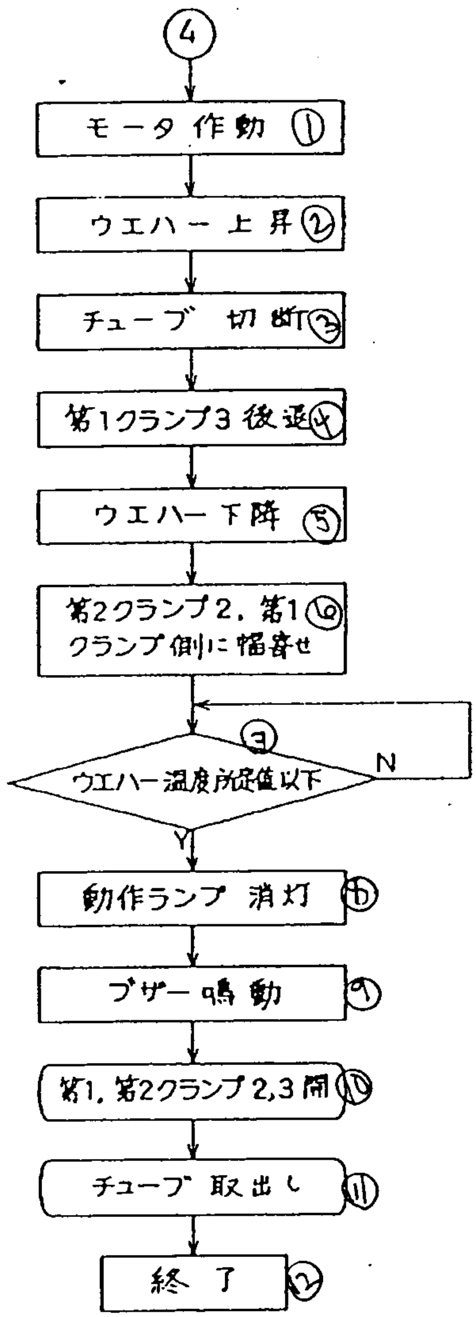

4
モータ作動 1
ウエハー上昇 2
チューブ切断 3
第1クランプ3後退 4
ウエハー下降 5
第2クランプ2，第1クランプ側に幅寄せ 6
ウエハー温度所定値以下 7
N
Y
動作ランプ消灯 8
ブザー鳴動 9
第1，第2クランプ2,3開 10
チューブ取出し 11
終了 12

Figure 13

Key:
1 Motor is turned on
2 Wafer is raised
3 Tubes are cut
4 First clamp (3) retreats
5 Wafer descends
6 Second clamp (2) laterally shifts towards the first clamp
7 Is the wafer temperature lower than the prescribed level?
8 Operation lamp is turned off
9 Buzzer is turned on
10 First and second clamps (2) and (3) are opened
11 Tubes are taken out
12 END

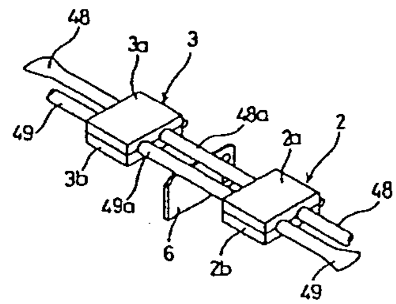


Figure 14

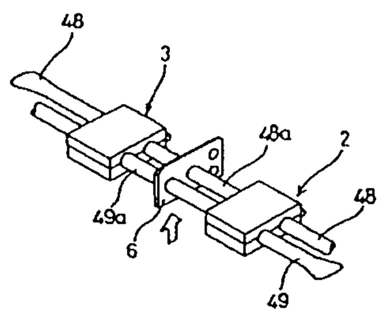


Figure 15

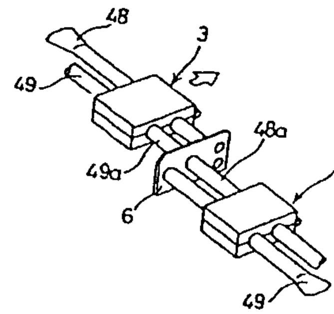


Figure 16

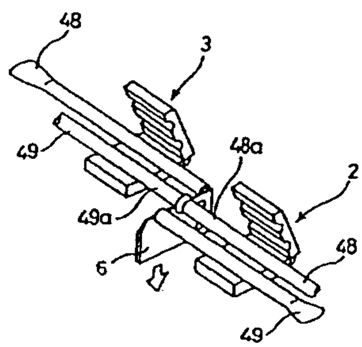


Figure 17

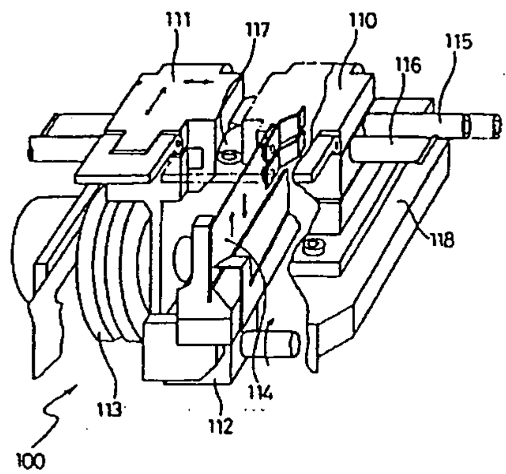


Figure 18